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ABSTRACT

A fundamental problem in language acquisition is determining how children learn the formal vocabulary of the adult grammar. A proposed solution is the Semantic Bootstrapping Hypothesis (SBH), which states that children infer the identity of syntactic entities such as "subject" in input based on the presence of semantic entities such as "agent." The hypothesis is a source of insight into and constraints on early notions of agency. For bootstrapping to work, children must be able to detect the presence of agents in parent-to-child speech/contexts. Because young children have not mastered the nuances of verb meaning, parents must use words whose semantic representations correspond closely to the child's conceptual encoding of a situation. A primitive notion of agency underlying this type of bootstrapping is developed in S. Pinker's theory of semantic representation. Furthermore, this research can account for some major variations in agency found across languages. Finally, SBH is supported by developmental evidence showing that children have syntactic categories and are sensitive to semantic information about agency. (Author/MSE)

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BOOTSTRAPPING FROM AGENCY: EARLY NOTIONS OF AGENCY ACCORDING TO PINKER'S SEMANTIC BOOTSTRAPPING HYPOTHESIS

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ABSTRACT

A fundamental problem in language acquisition is how children learn the formal vocabulary of the adult grammar, given that instances of syntactic categories, grammatical relations, and other syntactic elements are not perceptually marked as such in the input. A proposed solution to this problem, developed at length by Pinker (1982, 1984, 1987, 1989), is known as the Semantic Bootstrapping Hypothesis: children infer the identity of syntactic entities such as 'subject' in the input on the basis of the presence of semantic entities such as 'agent'.

The Semantic Bootstrapping Hypothesis is a source of insight into, and constraints on, early notions of agency. In order for bootstrapping to work, children must be able to detect the presence of agents in parent-to-child speech/contexts. Since young children haven't mastered the nuances of verb meaning, parents must use words whose semantic representations correspond closely to the child's conceptual encoding of a situation; under this constraint, children should at least be able to detect the presence of prototypical agents (volitional humans acting directly on patients). A primitive notion of agency underlying this type of bootstrapping is developed in Pinker's (1989) theory of semantic representation. Furthermore, Pinker (1989) can account, without extension, for some of the major variations in agency found across languages (DeLancey, 1984); to the extent that these types of agency can be communicated clearly in parental speech to young children, they are associated with the correct syntactic elements. Finally, the Semantic Bootstrapping Hypothesis is supported by developmental evidence showing that children have syntactic categories and that children are sensitive to semantic information about agency that forms the basis of bootstrapping.

The topic of this paper is how the bootstrapping problem, and Steven Pinker's particular solution to it, constrains -- or allows us to make predictions about -- early notions of agency. The paper is divided into five sections: the bootstrapping problem; the semantic bootstrapping hypothesis; the notion of 'agent'; variations in agency and causation; and development.

I. THE BOOTSTRAPPING PROBLEM

The bootstrapping problem is very simple, but I think profound. The child learning language hears only sentences in context, but must somehow on this basis formulate a grammar for the adult language. Crucially, this grammar is couched in a formal vocabulary, including (among other abstract elements) syntactic categories such as 'noun' and 'verb' and grammatical relations such as 'subject' and 'direct object'. The problem is that instances of formal vocabulary are not perceptually marked as such in the input. Nothing in the input tells the child what is the 'subject'; there is no unique perceptible marker that is attached to subjects across languages. And if the child generalizes on the basis of what can be observed in the input -- by attending to serial position, for example -- the wrong rules will be learned. Dilemma: how are grammatical relations identified on the basis of a seemingly irrelevant input? Henceforth I'll be talking about grammatical relations, and especially subjects in English; however, the bootstrapping problem applies to all formal vocabulary, in all languages. (See Pinker, 1987, for an excellent summary of the problem.)

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II. THE SEMANTIC BOOTSTRAPPING HYPOTHESIS

For a number of years, Pinker (1982, 1984, 1987, 1989) has been developing a solution to this problem known as the SEMANTIC BOOTSTRAPPING HYPOTHESIS (SBH): children infer the identity of syntactic entities such as 'subject' in the input on the basis of the presence of semantic entities such as 'agent'. Basically, the child has to be able to identify agents on the basis of context and content words in the input. Identifying agents does not itself raise the bootstrapping problem as long as certain assumptions are made. The following four assumptions hold in chronological order, if you will, in the process of bootstrapping. First, the presence of semantic elements need only be a SUFFICIENT (not necessary) condition for parental use of syntactic symbols in the input; all agents must be subjects, but not all subjects have to be agents (or else there would be no need to bootstrap). In support of this assumption, Pinker (1984) found, in an analysis of the Brown corpus, that agents were always expressed as subjects in parental speech. There were no full passives in the entire sample. For this reason, this assumption is not hard to swallow. A second assumption, one that really sheds light on early notions of agency, may be called COGNITIVE TRANSPARENCY: young children haven't mastered the nuances of word meaning, so adults must use words whose semantic representations correspond closely to the child's conceptual encoding of a situation. If there is a large gap between the conceptual structure for a situation and the semantic representation for the corresponding sentence in the input, young children will have no way to 'bridge' the gap. Situations involving PROTOTYPICAL AGENTS (human, volitional agents acting directly on patients) are presumably more transparent to young children than those involving non-prototypical agents. For example, the context of *John broke the vase* (especially if John acts intentionally) is likely to be more transparent to a two-year-old than the context of *John made the vase break*, *The wind broke the vase*, or *The vase was broken (by John)*. Therefore, prototypical agents are the most relevant to SBH. Third, if we can assume that the child has access to parental speech in cognitively-transparent contexts, the semantic representations of input sentences can be created from content words (learned independently of grammatical rules). Fourth, and finally, linking rules can be used by the child to infer (e.g.) that an agent specified in the semantic representation of an input sentence is the subject of a verb.

Although the focus of this paper is on the actual process of bootstrapping from agents, and on what that might tell us about early notions of agency, there are some important consequences of learning syntactic symbols via semantic bootstrapping (Pinker, 1984, 1987). These include the ability of the learner to engage in distributional learning, based on the correct categories, relations, and rules. For example, properties defined by learned rules/argument structures (e.g., *The cat* is a subject NP in *The cat scares the dog*) could be used to categorize abstract words (e.g., *The situation* is a subject NP in *The situation scares the dog*). Furthermore, the identification of syntactic categories and relations could provide constraints on the search for new rules. Thus, learning if the subject agrees with the verb in a particular language is much easier if the learner knows the identity of these elements; instead of making comparisons for every pair of elements in the input, on every potential feature, the search space has been reduced dramatically. Finally, the identification of syntactic categories and relations might allow the child to apply universal conditions automatically (e.g., to know, without additional learning from the input, that he or she can't extract a *wh*-phrase from the subject).[1]

III. THE NOTION OF 'AGENT'?

There are at least three 'levels' at which we can think about agency, with each lower level being more exclusive than the one above it:

- Every variation in agency that is communicable.
- Every variation in agency that is relevant to morphosyntax.
- Every variation in agency that is relevant to SBH.

We're only interested in the latter two levels; let's look at these one at a time. Pinker (1989) claims that every variation in agency that is relevant to morphosyntax is a discrete variation on a basic agent-patient relation. In particular, Pinker (1989) suggests that the force-dynamics framework of Talmy (1988) provides a way of understanding this basic relation. Force interactions involve the opposing forces of two entities, each conceived as a body with an intrinsic tendency towards rest or motion. Languages differentiate between two types of force-exerting entities, depending upon which one is being focused on: the focal force entity, called the AGONIST, and the force entity that opposes it, called the ANTAGONIST. On this account, an 'agent' corresponds to an 'antagonist' (underlined in the following examples); a 'patient' corresponds to an 'agonist'.

Now admittedly, this characterization of 'agent' is very abstract. However, Pinker is not using *agent* as a defined term, but rather as a primitive, and the intuition behind the primitive status of 'agent' is provided by Talmy's force dynamics work. Force dynamics provides a framework for understanding a variety of related notions in a systematic way, including: whether the antagonist is stronger than the agonist (*John made the lamp topple*) or weaker (*The lamp stayed on the table despite John's effort to make it topple*); if the antagonist is stronger, whether 'causing' is involved (*The pump made the water flow from the tank*) or 'letting' (*The plug's coming loose let the water flow from the tank*); if causing is involved, whether it is causation by onset (*The wind made the ball roll*) or within a steady state (*The wind kept the ball rolling*). Notice that in these examples the antagonist may be a human, an instrument, or a natural force. One of the appealing aspects of this system is that it provides an abstract characterization of agency and causation which has ramifications throughout the language despite differences in the type of antagonist. Of course, whether an antagonist is a human or a dog or an instrument or a force may have morphosyntactic consequences in some languages -- so we'll have to mark such distinctions in some fashion (a topic we turn to below).

Concerning the narrowest conception of agency, the type of antagonist that is most relevant to SBH is the prototypical agent: human antagonists whose intrinsic force tendency is volitional. The reason for this, as noted as above, is that the role of a prototypical agent in an action is usually cognitively transparent. A related issue is WHERE prototypical agency applies. According to Pinker (1989), prototypical agency is specified in the semantic representation of a verb. For example, John is a prototypical agent in *John toppled the lamp* because the semantic representation of the causative verb *topple* specifies that a (usually) human agent acts directly on a patient causing it to move down in a toppling manner. (It's worth mentioning that linguists such as Halliday (1968) and Cruse (1973) share this view that agency is relational is character, holding between a verb and a noun.) Formally (see Pinker, 1989), *agent* is a mnemonic for the first argument of a dyadic primitive predicate ACT in the lexical semantic representation of a verb. A prototypical agent has the default property of being human.

In remainder of this paper, I'll discuss how SBH applies to non-prototypical agents, if at all, and try to summarize the developmental issues and evidence that bear on SBH.

IV. VARIATIONS IN AGENCY AND CAUSATION: CONTROL, DIRECTNESS, AND PERSPECTIVE.

The theory of semantic representation presented in Pinker (1989) can account, without significant extension, for some of the major types of agency represented in the world's languages, and furthermore (via the accompanying linking theory) for the general morphosyntactic ways in which those meanings are expressed. According to DeLancey (1984, 1985), certain subcategories of agency recur across languages, and differences between subcategories are often reflected morphosyntactically. One well-known variation in agency involves CONTROL -- the property attributed to the 'ultimate causer' or the 'head' of a causal chain (see DeLancey, 1984). For example, the argument corresponding to Bill has control in ***Bill*** *broke the window*, whereas the argument corresponding to the axe lacks control in ***The axe*** *broke the window*. Formally, the property of '+control' is approximated in Pinker (1989) by the property of '+human' attributed to the agent. (Control is usually attributed to human agents by virtue of their volitionality, but it is true that in some cases volitionality, humanness, and control can be separated.) A second variation, in causation rather than the nature of the agent per se, involves DIRECTNESS: the property attributed to causal chains that are not extended, that do not involve intermediates (see Shibatani, 1976; Haiman, 1983; DeLancey, 1984). For example, causation is direct in the case of ***Bill*** *broke the window*, but indirect in the case of ***Bill*** *made the window break by startling the carpenter, who was installing it.* In Pinker (1989), direct causation is a consequence of a dyadic ACT in the semantic representation of a verb; indirect causation follows from a monadic ACT. A third variation is PERSPECTIVE: whether an agent is foregrounded or backgrounded (see Foley & Van Valin, 1984, 1985). Thus, the argument corresponding to Bill is forgrounded in ***Bill*** *broke the window*, but backgrounded in *The window was broken by* ***Bill***. Differences in perspective are represented in Pinker (1989) by the level of embedding, if any, of an ACT in semantic structure.

Since each of the variations in agency is independent of the others we can combine them to arrive at the following list of eight deviations from prototypical agency. Each combination of semantic values corresponds ('-->') to a particular syntactic form (e.g., active lexical causative) in which the agent argument is expressed (e.g., transitive subject):

1. +control, +direct, +foreground --> active (lexical causative), tr. subject
John shaved Bill. The storm broke the window.[2]

2. +control, +direct, -foreground --> passive, obl. object (*by*)
Bill was shaved by John. The window was broken by the storm.

3. +control, -direct, +foreground --> active (periphrastic causative), intr. subject
John made Bill shave.

4. +control, -direct, -foreground --> passive (of matrix verb), obl. object (*by*)
Bill was made to shave by John.

5. -control, +direct, +foreground --> active, tr. subject ('intermediary instrument')
The axe broke the window.[3]

6. -control, +direct, -foreground --> intransitive (unaccusative), obl. object (*from*)
*The window broke ?from an axe (*by an axe / *with an axe). John died from a disease.*[4]

7. -control, -direct, +foreground --> active (periphrastic causative), intr. subject
The ball caused the lamp to break, by knocking the table on which it was standing.

8. -control, -direct, -foreground --> obl. object (*with*) ('instrument')
John broke the window with an axe. The window was broken with an axe.

The main point of this list is to show that Pinker (1989) actually accounts for a wide range of correspondences between type of agent and type of morphosyntax. The reason that this is important is that we don't want, say, the sort of agency of a true instrument (8) to lead a child to conclude that what adults take to be an oblique object of *with* is for the child a subject (e.g., with a prepositional case marker). This potential error can be avoided if children are equipped to represent the semantic differences between instruments and prototypical agents, bootstrapping from the former to oblique objects of *with* and from the latter to subjects. Furthermore, a critical issue concerning these major deviations from prototypical agency is the extent to which they are even relevant to SBH: if major deviations from prototypical agency are cognitively transparent in parent-to-child speech/contexts, they are relevant to SBH; obviously, not every grammatically-relevant variation in agency is cognitively transparent to two-year-olds. Of these eight types of agency, only (1) and (8) -- at the extremes of this feature system -- are probably relevant to SBH. Some evidence for this claim is that the forms in (2)-(7) are themselves extremely rare in English parent-to-child speech. Of course, even if some of these forms were used there is no guarantee that the corresponding notions of agency would be cognitively transparent.

A final point about Pinker's (1989) view of agency is that the similarity between types of agency is due to a shared semantic primitive (ACT) in semantic structure; however, the 'prototype' of agency does not arise from the semantic level of representation per se. This approach leaves open the question of why a favored status is accorded to volitional humans acting directly on patients. It seems clear that some (cognitive) iconic and economic motivation underlies this prototype structure (see Haiman, 1983). Despite the complex issues of what constitutes a causal chain, where it really begins, how many links are involved, and so forth, we as speakers choose the economy of regarding agents as prototypically human because we ascribe free will to ourselves, and because we are naturally interested in ourselves; we are the beginnings (and ends) of many a causal chain. On the other hand, causation is prototypically direct under the influence of iconic motivation: linguistic distance mirrors conceptual distance.

V. DEVELOPMENT.

SBH assumes that the primitive semantic category of 'agent ' (first argument of ACT) exists throughout the relevant period of development. The category of 'subject' exists as well, but it must be identified for a particular language. Given these assumptions, SBH claims that children can induce the identity of the subject on the basis of its being linked to

the prototypical agent. This relationship can be made obvious to children as long as parents, in their speech to children, evoke cognitive representations in their children that correspond closely to the semantic representations of the spoken sentences. In addition, if major deviations from prototypical agency are cognitively transparent in parent-to-child speech/contexts, they are relevant to SBH and can be linked to the correct syntactic elements. If not, they won't play a role in bootstrapping; they will be learned in the same way that other aspects of verb meaning are acquired (see Pinker, 1989).

Two distinct types of developmental claims follow from SBH. First, children must have syntactic (as well as semantic) categories. This is a claim about the type of categories that children's knowledge of language is couched in. Support for this claim comes from work done by Virginia Valian (1986) and Paul Bloom (in press), among others. Bloom shows that young children avoid uttering sequences with an adjective followed by a proper name or a pronoun, even though they don't avoid uttering sequences with an adjective followed by a common noun, and they don't -- at a slightly older age -- avoid uttering adjectives in the predicate position, preceded by proper nouns, pronouns, or common nouns. For example, young children never say things like *big Fred* or *big he*, even though they do say things like *big dog*, *Fred (is) big*, and *he (is) big*. Bloom concludes that the only plausible explanation for this is that children have knowledge of abstract linguistic categories, such as that proper nouns and pronouns are NPs, and knowledge of word order through rules that order abstract linguistic categories, such as 'NP-->Adj N' (but not 'NP-->Adj NP').

A second developmental claim following from SBH is that children must use semantic information to identify the syntactic categories. This claim is more difficult to test than the first because it concerns children's actual learning (mapping from input to competence) rather than their competence at any stage. At the very least, it seems to be the case that children are sensitive to the relevant semantic information -- a prerequisite to bootstrapping from it. Evidence for this comes from the fact that young children talk about agents and causes (e.g., Bloom, Lightbown, & Hood, 1975; Braine, 1976; Budwig, 1989; Clark & Carpenter, 1989a, 1989b). In addition, some of the hypothesized correspondences used by young children in bootstrapping are presumably continuous with the correspondences between semantic arguments and grammatical functions that have been shown to be exploited by older children in learning verb argument structures (Gropen, Pinker, Hollander, & Goldberg, in press, in preparation).

A final developmental claim, which bears indirectly on SBH, is that a major source of children's syntactic errors will be incorrect or non-adult semantic representations for particular lexical items (as opposed to immature linking rules; see Pinker, 1989; Gropen et al., in press). For example, Budwig (1989) shows that young children choose different self reference forms to mark distinct perspectives on agency. This tells us something, at the very least, about the immature semantic representations of particular lexical items (i.e., pronouns and names), and is consistent with the view that children may have an overly narrow 'recognition procedure' for agent referents (see Huttenlocher, Smiley, and Charney, 1983). (Of course, an overly NARROW conception of 'agent' poses no difficulties for SBH.) A second example comes from Eve Clark and Kathie Carpenter (1989a,b), who show that young children (about two years of age) substitute *from* for *by* to mark agents. The authors argue that the children's substitutions arise because agents and causes are conceptualized as types of sources -- *from* is being used as if it MEANT (passive) *by*.

Why do these particular errors occur? It may be the case that a significant proportion of children's non-standard speech arises in cases where the assumption of cognitive transparency not merely fails, but MISDIRECTS (see Gropen et al., in press, for evidence from older children). Furthermore, instances of 'cognitive misdirection' plausibly point to the operation of cognitive universals -- such as the tendency of agents to be sources.

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NOTES

1. As should be clear from this last consequence of SBH, Pinker considers a grammatical relation to be universal by virtue of a set of universal properties or tendencies holding of such formal categories (e.g., see Keenan, 1976, on the universality of 'subject'). In fact, Pinker (1987) proposes that a set of models of formal-vocabulary acquisition, CONSTRAINT SATISFACTION, might help solve the bootstrapping problem by putting less reliance on bootstrapping from any one property of a grammatical relation. So, instead of the child just using the universal tendency for agents and causal forces to be subjects in active, declarative sentences, the child would take advantage of the full set of unmarked rules for subjects: for example, subjects tend to precede objects, NP positions in tensed clauses can be subjects, features of the subject can be encoded in verbal affixes, and so on. According to these models, the child uses incomplete representations of the input, plus the unmarked rules, in order to create the set of actual rules for his or her language. Constraint Satisfaction may be a process by which syntactically ergative languages are acquired, or incorrectly processed sentence/context pairs are recovered from.

2. Natural forces, computers, etc., may be assimilated to prototypical agents; see Cruse, 1973, for a similar view.

3. Restrictions on the acceptability of 'intermediary instruments' as transitive subjects (see Cruse, 1973) suggest that the '-control' feature must be present to distinguish them from case (1) (e.g., *John broke the window*); however, their grammaticality in English is made clear by their acceptability relative to transitive forms with 'enabling instruments' as subjects (e.g., **The spoon ate the pudding*; see Levin, 1985).

4. For a related form, see DeLancey (1984) on *k'é* constructions in Hare, an Athabaskan language.